OHDZ
373.23609713
O59DE/iES

ONTARIO DEPARTMENT OF EDUCATION

CURRICULUM 1 - 21

ENVIRONMENTAL SCIENCE
An Experimental Course for Grade 9

1967

ONTARIO DEPARTMENT OF EDUCATION

CURRICULUM 1 - 21

ENVIRONMENTAL SCIENCE
An Experimental Course for Grade 9

1967

This course is presented so that schools may continue to develop their science programs. The working draft presents new approaches and new resources which may serve to enrich programs in current use.

This working draft is circulated for study and for optional implementation in part or as a whole.

In the development of this outline, invaluable assistance was received from many individuals and groups. Comments and suggestions will be welcomed to assist in the development of a more definitive course.

The three column format in which the course is presented aims at allowing teachers greater freedom. In the first column, teachers will find the broad principles that should be treated in development of the course. The teacher may develop these principles in various ways, depending on the interest and capabilities of his students. Column two provides suggested details for expansion of the broad principles, while column three provides interpretation and background to fit those principles into the framework of the world in which we live.

Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

https://archive.org/details/environmentalsci00onta_2

PREAMBLE

As communication technology shrinks our earth and as research technology expands our knowledge, new problems are created for all of us. In the past, problems that beset family or community were local--solved by the limited knowledge and resources of the groups involved. Many problems facing man today have universal scope, and can only be met by using the collated knowledge and resources of all mankind.

The problem of obtaining food for the family has become one of obtaining food for families of nations. As a family unit grows, it acquires an extra burden, the task of providing sufficient food for itself. Growth in a family of nations imposes the same burden on a larger scale, one that must be shared by every individual.

Problems facing all mankind today are manifold: producing enough food, controlling population growth, combatting the pollutants that contaminate our environment, controlling the diseases that attack man, plants, and animals, and developing plans for more economic utilization of lands and other resources. Environmental Science is a program that will enable a student to identify some of man's major problems, to discuss them objectively, and to pose workable solutions. An appreciation of the basic principles of all branches of sciences, and their application to the environment should enable each man to understand and control the forces around him for the benefit of all men.

Control of the environment depends on widespread use of ever-increasing technical knowledge. As knowledge of environmental manipulation increases, man is able to produce more food more economically and efficiently, while faulty manipulation leads to pollution, extermination of plant and animal species, and inadequate food supplies.

Control of environment is as old as history. From early times, with crude tools and limited knowledge, man sought to wrest the basic requirements of living -- food and shelter -- from his environment. His quest for food is an endless cycle of energy conversion from inedible to edible and back to inedible forms. The soil, the water, and the air are inextricably bound to all plants and animals in the conversion of energy from one form to another. With an understanding of such interrelationships, man can manipulate any part of his environment to produce the ever-increasing quantities of energy required.

Today we have become a society of consumers removed from direct contact with the conversion, collection, and storage of energy in the form of food, but because each of us is a consumer, it is essential that we appreciate man's efforts to obtain his food supply. The dynamic involvement of scientific knowledge and technology with the use of our natural resources is an exciting chapter in human history. In fact, it is the story of civilization.

INTRODUCTION

Environmental Science deals with the continuous cycling of energy through life forms and focuses on man's manipulative skills in adjusting the natural cycle to his requirements.

THE PROGRAM HAS TWO OBJECTIVES:

(1) To develop an appreciation of our environment through an understanding of fundamental biological and physical processes;

(2) To develop an understanding of man's manipulation of his environment to meet his biological and cultural needs.

The program is based on sets of principles augmented by suggested topics for investigation and by a suggested interpretation of those topics.

A variety of approaches is possible, depending on the interests and needs of the students. The approach suggested is agriculturally inclined because of the universal interest in food supplies and because of the facilities currently available in schools.

An investigation of each principle should be pursued to whatever depth is suitable to the students' needs and interests, to the nature of the community, and to probable optional courses at the senior grade levels.

The program should be based on pupil-centred investigations with an opportunity for both individual and group inquiry. Where possible, a quantitative approach should be combined with extensive use of data collecting, graphing, and interpretation of results.

Curriculum Study Guides will accompany the outline to indicate resource materials, to suggest depth of treatment of selected topics, and to provide a list of possible suitable student experiments and activities.

ENVIRONMENTAL SCIENCE

Grade 9

UNIT I

THE ENVIRONMENT SUPPLIES HUMAN NEEDS

A. - THE BASIC PHYSICAL REQUIREMENTS OF LIFE ARE PROVIDED BY OUR NATURAL ENVIRONMENT

1.Food

(a) Food as a source of energy
(b) Sources of food
(c) Energy conversion
- plants as primary collectors and convertors
- animals as secondary collectors and convertors

2.Fibre
- plant and animal

3.Fuel

ENVIRONMENTAL SCIENCE involves man's manipulation of his environment to enable him to control and manage the flow of energy from the sun through living things. It is concerned with the basic laws of science and their interaction, all of which are fundamental if man is to understand his environment and wrest his energy requirements from it.

UNIT I

THE ENVIRONMENT SUPPLIES HUMAN NEEDS

Energy originating with the sun is converted through one life-form to another and provides the individual requirements of each form. The dynamic cycling of energy through living things may be called the Energy Concept.

Most of man's needs relate to this cycling of energy with fundamentals of survival such as food, air, and water. The relationship is direct. With more sophisticated requirements, such as shelter or fuel, it is indirect. With intangible needs like aesthetic and cultural requirements, the relationship may be more indirect still. But regardless of the degree of involvement, all of man's vital requirements cannot be fully appreciated without an understanding of environment.

Unit I of Environmental Science introduces the Energy Concept and its relationship to man's basic needs. This theme is developed throughout the course and is reflected in each principle on which the course is constructed.

A. - THE BASIC PHYSICAL REQUIREMENTS OF LIFE ARE PROVIDED BY OUR NATURAL ENVIRONMENT

Man's survival depends on an adequate food supply. Throughout his existence, he has had to struggle to increase the amount of available food to meet the demands of an increasing population.

Standards of living depend directly on the efficiency with which food is produced. Generally speaking, if more than one-half of a population is needed for food production, a low standard of living results.

UNIT I

B. - MAN REQUIRES CULTURAL AND AESTHETIC SATISFACTION

1. Recognition of cultural needs

2. The contribution of our environment in satisfying cultural and aesthetic needs

   (a) Food - stimulation of our senses
   (b) Plants in natural, public, private, and industrial areas
   (c) Animals - wildlife, pets, domestic animals
   (d) Others
   - desire to own property
   - appreciation of our Canadian environment and our responsibility for its wise use
   - appreciation of interrelationship of living things
   - appreciation of satisfaction of working with living things
   - appreciation of rural-urban interdependence

UNIT I

B. - MAN REQUIRES CULTURAL AND AESTHETIC SATISFACTION

Man is an animal in the biological sense but, unlike other animals he requires intellectual stimulation. Literature, art, and music may satisfy his cultural and aesthetic needs in an abstract way, but, in addition, man derives a great deal of tangible satisfaction from a direct involvement with his surroundings.

Much of our culture and civilization is a natural outgrowth of the various stages of our quest for food. A chance food-gathering stage evolved into a more positive approach of food hunting. This in turn was followed by the domestication of animals and a nomadic existence. With the subsequent domestication of plants, a recognizable agricultural phase became evident.

Paralleling the development of an experimental approach to other fields of science was the development of man's attempts to increase the quality and quantity of his agricultural products. This development is continuing at an accelerating pace and is freeing greater numbers of men from food production. More time for cultural pursuits is a natural result.

UNIT I

C. - MAN IS INCREASING HIS INFLUENCE OVER ENVIRONMENTAL FACTORS TO SUPPLY HIS NEEDS

1. Man's increasing awareness of his environment

2. The increasing application of technological knowledge to solve environmental problems

3. The increasing need to feed others

4. The increasing impetus of scientific research

UNIT I

C. - MAN IS INCREASING HIS INFLUENCE OVER ENVIRONMENTAL FACTORS TO SUPPLY HIS NEEDS

Scientific research cannot wait for nature anymore.

Man now has become aware of his environment enough to recognize adjustments that can lead to either specific benefits or disaster. Already he can convert large areas of land quickly, bulldoze an area flat, or build a hill, plant a forest or annihilate one, irrigate a desert or create one.

Man can accomplish all this, and feed and clothe his neighbour, for whom he feels increasing responsibility, if two basic needs of the future are met: continued scientific research in the laboratory and increased application of technological developments on farm and forest. Man now is closer to the goal that has haunted him since prehistoric times -- domination of his environment.

The principles that form the basis of Unit I are fundamental in an understanding and appreciation of man's environment. Man's vital requirements are obtained directly from his environment, or are a result of his reactions to it. Inextricably woven into the fabric of his needs is a cycle of energy transferral. The cycle is arrested in the production of his fibre, is short-circuited in the production of fuel, and is completed as food is produced, utilized, decomposed, and produced again.

UNIT II

PLANTS ARE PRIMARY CONVERTERS OF ENERGY

A. - SEED PLANTS ARE THE MAJOR CONVERTERS OF ENERGY INTO FOOD AND FIBRE

1.(a) The largest and most valuable of all plant groups
(b) Prime suppliers of man's food

2.Experimental study of seed to show:
(a) An embryo plant with a supply of stored energy
(b) Types of seeds and parts determined by observation
(c) Requirements for germination as determined by experiment
(d) Germination and emergence procedures

UNIT II

PLANTS ARE PRIMARY CONVERTERS OF ENERGY

A. - SEED PLANTS ARE THE MAJOR CONVERTERS OF ENERGY INTO FOOD AND FIBRE

Basic to the knowledge of a seed plant is the significance of the seed itself. Seed plants are the largest and most valuable of all plant groups. They are the principal suppliers of man's food. The obvious use of procreation to continue the species is only one of a host of uses man has for seeds. Much of his food is in the direct use of seeds as a food source. The stored food in the seeds of cereal grains, beans, and nuts has been used for centuries. Paints, lubricants, oils, seasonings, and medicines are a few of the other uses man has created for seeds.

Planting seeds of specific types at specific times and in chosen quantities enables man to control a great deal of the nature of the plant growth in his environment.

Seeds pass through varying lengths of dormancy, and, if viable, they respond to suitable environmental conditions by germinating. Knowledge of these conditions and their manipulation gives man an extraordinary control over the development of new crops of plants.

UNIT II

B. - THE GREEN PLANT COLLECTS RADIANT ENERGY, CONVERTS AND STORES IT

1. (a) Importance of photosynthesis
(b) Essentials of photosynthesis
. chlorophyll
. light
. temperature
. carbon dioxide
. water
. plant nutrients
(c) Products of photosynthesis: glucose, oxygen

2. Utilization of products of photosynthesis:
(a) Respiration: symbolic chemical representation, oxidation of glucose
(b) Growth: cell division, enlargement, and specialization
- vegetative growth
- reproductive growth
- factors involved in growth:
  . energy source
  . temperature
  . water
  . plant nutrients
  . enzymes
  . hormones
(c) Storage
. purposes of energy storage
. organs of storage
  - regions of storage
  - basis for a classification system as annual, biennial, perennial
. detailed study of the bulb, out-door planting, and forcing
(d) Biosynthesis - building other substances from glucose
. carbohydrates - complex sugars, starches, cellulose
. proteins
. oils
. other complex compounds: chlorophyll, hormones, DNA
(e) Differentiation: using excess glucose

UNIT II

B. - THE GREEN PLANT COLLECTS RADIANT ENERGY, CONVERTS, AND STORES IT

The photosynthetic process is the initial stage of all food production. Solar energy triggers a series of chemical activities within green plants to produce food forms that can be utilized by animals and in turn converted to other food forms.

Chlorophyll could be termed the chemical that is the key to all survival as we know it. It is vital for the conversion of low-energy compounds into those with a high-energy potential.

The decomposition of high-energy compounds within an organism releases the energy necessary for the life processes. This aspect of the metabolic process within organisms is called Respiration.

When energy requirements are adequate, a growing organism increases in size, volume, or fresh weight. The division of cells within the organism and the subsequent growth of each resultant cell enables the whole of a living thing to grow. At maturation, a living plant or animal has developed reproductive organs which in turn mature and produce the sex cells necessary for the following generation.

A great deal of energy is stored within a plant for the perpetuation of the species. Man, the opportunist, utilizes this stored energy as a direct source of food. The type of storage system of plants can be used as a basis of classification.

All of man's food requirements can be produced by plant growth. Biosynthetically, glucose can be reconstructed into carbohydrates, fats, proteins, and vitamins, which are essential components of man's diet. Glucose that is not converted into these components is utilized in growth and differentiation. In growth, the glucose is used to build more structure or is used in storage.

Differentiation is an irreversible process in most cases and produces end products such as the nicotine in tobacco, pigment in red apples, and aromatic compounds. As the end products accumulate, photosynthesis slows down and accelerates differentiation.

UNIT III

PLANTS HAVE A DEPENDENCE ON THE PHYSICAL AND CHEMICAL COMPOSITION OF SOIL

A. - THE PHYSICAL COMPOSITION OF SOILS INFLUENCES PLANT GROWTH

1. The primary role of soils as a "bank"
   (a) Soil as a medium for plant support allowing various plant orientations to collect radiant energy

2. Physical composition of soil
   (a) Presence and sources of various types of matter in soil
   - solid portion
     (i) mineral matter
     (ii) organic matter
       - non-living
       - living: macro-and-micro-organisms
   - non-solid portion
     (i) air
     (ii) soil solution: water, plant nutrients
   (b) Percentage composition of desirable soil; variations by weight and volume

3. Soil types: Textures and Structure
   (a) Origin of sand, silt, clay, muck - source, use, description, and microscopic observation
   (b) Soil texture: - a classification based on size of mineral particles
   - common soil types: sand, loams, clays, muck
   (c) Soil structure: arrangements of mineral particles into aggregates
   Types of soil structure
   - single grain structures - sand
   - aggregates or crumb structure in clay
   Importance of good soil structure

4. Soil Water
   (a) Importance of water
   (b) Types, location, movement and use of soil water
   - gravitational (free)
   - capillary (film)
   - hygroscopic (bound)
   (c) Capillary movement and use in various soils (sand, clay, muck)
   (d) Determination of water-holding capacities of common soil types
   - compare water absorbing capacities of various soils

UNIT III

PLANTS HAVE A DEPENDENCE ON THE PHYSICAL AND CHEMICAL COMPOSITION OF SOIL

A. - THE PHYSICAL COMPOSITION OF SOILS INFLUENCES PLANT GROWTH

Although carbon dioxide and water are essential compounds required for the photosynthetic processes, plant nutrients necessary for the production of fats, proteins, minerals, and vitamins are obtained from the soil. The lack of locomotory systems in plants necessitates a fixed support to facilitate the acquisition of sufficient radiant energy.

The vital nutrients in the soil can be controlled to a marked degree. The addition of chemicals to soil enables the growth of crops in previously useless land, since man has ascertained the optimum conditions of soil nutrition required for maximum crop yields and he is able to predict what that yield should be.

The composition of soil has a direct effect on plant growth. The textural quality and structure of soil are controllable factors that can be manipulated by man.

UNIT III

B. - THE CHEMICAL COMPOSITION OF SOILS INFLUENCE PLANT GROWTH

1. Compare soil to a bank account
   (a) Elements or nutrients required by plants
   . elementary study of sources and use of plants
   . major elements - nitrogen, phosporous, potassium
   . minor elements
   . common limiting elements - nitrogen, phosphorous, potassium, calcium, magnesium

2. Soil Depletion
   (a) Chemically - cropping, weeds, leaching, erosion
   (b) Structurally - e.g., weight compaction

3. Soil Replenishment
   (a) Commercial fertilizer - to show necessity to replace nutrients removed
   (b) Animal Residues
   (c) Plant Residues

4. Fertilizer Analysis
   (a) Significance of analysis - e.g., 10-10-10

5. Soil Reaction
   (a) Importance in relation to ability of plants to absorb plant nutrients

6. Soil Tests
   (a) Use
   (b) Method

UNIT III

B. - THE CHEMICAL COMPOSITION OF SOILS INFLUENCE PLANT GROWTH

The nutrients present in soil are analogous to a trust fund in a bank. Soil nutrients can be depleted just as a trust fund can be used up. In turn addition of nutrients and money can replenish the soil and the trust fund respectively. Some soils have the good fortune to be richly endowed with nutrients and man tends to waste this wealth, but other soils are starved of nutrients and require the judicious and scientific application of more.

UNIT IV

ANIMALS ARE SECONDARY ENERGY CONVERTERS

A. - THE ANIMAL COLLECTS, CONVERTS AND CONSERVES THE VARIOUS FORMS OF STORED PLANT ENERGY WHICH HUMANS CANNOT USE.

1. (a) Use of land - animals can harvest stored energy on land unsuited to economic production of human food
   (b) Animals produce high quality foods by upgrading and conversion.
   (c) Other animal products - hides, hair, wool, drugs, fertilizer, glue
   (d) Recreational use of animals.

2. Comparison of digestive systems based on differences in the stomachs of the common food-producing animals and their efficiency as energy convertors.
   (a) Glandular - domesticated and wild fowl (insects as competitors)
   (b) Simple - (i) non caecal - pig (rodent as competitors)
   (ii) caecal - refer to significance of caecum in some animals (horse, rabbit, fish)
   (c) Complex - ruminant - cattle, sheep, goat, deer, moose.

UNIT IV

ANIMALS ARE SECONDARY ENERGY CONVERTERS

A. - THE ANIMAL COLLECTS, CONVERTS AND CONSERVES THE VARIOUS FORMS OF STORED PLANT ENERGY WHICH HUMANS CANNOT USE

The term animal is used in different ways in different contexts. In reference to food production, "animal" usually refers to mammals, fish, and birds whether domesticated or wild. Other animal forms such as arthropods and annelids will be used more extensively as a food source, as protein sources become increasingly inadequate.

When transferred to the body of an animal, a small percentage of the energy produced photosynthetically is stored. However, many plant forms are not usable or palatable to man, and conversion to an animal form first provides an additional food source. Some plant growth is low in digestibility or in energy content. It can achieve high digestibility and energy content by conversion to an animal form.

The history of the domestication and utilization of animals is intimately associated with various civilizations. Today some traditional uses of animals as sources of food, transportation, clothing, and shelter are being drastically affected by the production of synthetic fibres and food, and the mechanization of transportation.

An understanding of the digestive systems of animals enables us to assess their value as energy convertors for man's use. In general, the shorter digestive tubes require a higher quality of food but are more efficient convertors. However, animals with this type of digestive system tend to compete with man for the same food; it would appear that more animals not in competition with man should be produced.

Digestive systems may be classified by their structure and function in terms of the presence of glandular mechanism, the presence of a caecum and the compartmentalizing into a complex stomach.

UNIT V

MAN INCREASES HIS PLEASURE AND SATISFACTION THROUGH THE USE OF LIVING THINGS AND HIS ENVIRONMENT

A. - PLANTS MODIFY OUR ENVIRONMENT AESTHETICALLY

1. Effects achieved by plants
   (a) Appeal to senses
   (b) Control of microclimate - shade, temperature, wind

2. (a) The use of landscaping in private, public and commercial areas

3. Common types of plants used in landscaping arrangements
   (a) Annuals
   (b) Perennials
   (c) Flowering Shrubs
   (d) Evergreen Shrubs
   (e) Shade Trees
   (f) Fruit Trees
   (g) Hedges
   (h) Roses
   (i) Lawns

4. Methods of planting common types of landscape materials.

B. - ANIMALS MODIFY OUR ENVIRONMENT AESTHETICALLY

1. Animals in natural environments

2. Animals in man-controlled environments

UNIT V

MAN INCREASES HIS PLEASURE AND SATISFACTION THROUGH THE USE OF LIVING THINGS IN HIS ENVIRONMENT

A. - PLANTS MODIFY OUR ENVIRONMENT AESTHETICALLY

Beauty is a necessity of life -- even blind people are cheered by brightly painted walls and depressed by drab surroundings. For the sighted, beauty of surrounding is even more important and mankind has constantly experimented with new means of adding ornament to his environment: painting, sculpture, and architecture, to name only a few, have sustained the human spirit through hundreds of years.

The basic source of beauty, however, springs from plant life.

Plants are a bounteous source of beauty in our homes, cities, rural landscapes, parks, campuses, gardens, conservatories, greenhouses and areas of the great outdoors.

They furnish a setting for many recreational events from picnics in the outdoor living area of a home to the tough turf of a football field and the carpet-like putting green of a golf course.

Town planners are expressing the same axiom when they seek to protect park lands from commercial encroachment. Most community planners now base their activities on a standard of 20 acres of parkland for each 1,000 of population. Another tacit recognition of the importance of natural beauty is a by-law now in effect in many new subdivisions -- builders must donate five percent of the land they develop for community parks.

In order to develop the open spaces needed for a healthy and attractive environment, whether a window box or a provincial park, man must have the knowledge to control plant life. Flowers and shrubs can be manipulated to man's requirements up to a point, but they also follow their own rules, and man must know those rules if he is to produce the park lands and open spaces which the human spirit needs.

B. - ANIMALS MODIFY OUR ENVIRONMENT AESTHETICALLY

The same applies to animals and to their relationship with plant life. Horses, for instance, are no longer a necessity for transportation, but they are still objects of beauty to those who see them, ride, drive, breed, or race them. Other animals also add to the beauty of man's environment -- deer, moose, and elk as well as birds and fish increase the appeal of large parks and game preserves a hundred fold. But in each case, man must understand the requirements of the animal in order to maintain this particular ornament of the countryside.

UNIT VI

THE FOREST ENVIRONMENT FULFILLS SOME HUMAN NEEDS

A. - THE FORESTS CONVERT AND CONSERVE ENERGY

1. The Role of the Tree as a Convertor
   (a) Economic importance of the tree in land utilization
   - on large natural areas
   - on cultivated areas
   (b) Producer of useful products
   (i) fibre
   - building products
   - cellulose, films and filaments, rayon, viscose, acetate
   - paper
   - other products: oils, resins, acids, dyes
   (ii) food
   - human
   - animal

2. The Role of the forest in conservation of Natural Resources
   (a) The forest as a natural community - ecological development
   (b) The forest as an agent of conservation
   . energy
   . soil
   . water
   . animal

3. The role of man in manipulating the forest
   (a) Seeding, re-establishment, re-forestation
   (b) Enemies of the forest
   (c) Forest care
   (d) Harvesting

B. - THE FORESTS SERVE AS RECREATIONAL AREAS

1. Natural forests

2. Parklands

UNIT VI

THE FOREST ENVIRONMENT FULFILLS SOME HUMAN NEEDS

A. - THE FORESTS CONVERT AND CONSERVE ENERGY

Knowledgeable citizens can prevent the depletion of natural resources such as forests. Trees hold enormous quantities of energy in a form that is easily converted into a host of usable products. A disregard of the need to recycle energy back into the forest results in an increasingly useless resource. The application of scientific and technological knowledge to the management of forest resources is of increasing significance, and is resulting in improved resource utilization.

B. - THE FORESTS SERVE AS RECREATIONAL AREAS

Fortunately the forest represents an easily controlled resource, and by careful manipulation through reseeding reforestation and forest care, the forest can continue to provide man with food, fibre, fuel and recreation indefinitely.